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(19)

(54) INSULATION-PIERCING CONTACT MEMBER AND ELECTRICAL CONNECTOR

(71) We, BUNKER RAMO CORPORATION, a Corporation organised and existing under the laws of the State of Delaware, United States of America, of 900 Commerce Drive, Oak Brook, Illinois, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to electrical contact members.

In multi-circuit electrical connectors, used in great variety and numbers in communication systems and other data handling systems, the usual technique for connecting circuit elements such as individual solid or stranded wire conductors to the connector has been to strip the insulation from the end of the conductor and then solder the conductor to a connector contact. This procedure requires considerable skill on the part of the workman making the solder connection, particularly in miniaturized connectors. There is also a tendency to bridge the adjacent contacts within the connector, producing undesirable circuit connections.

An alternative technique gaining increasing acceptance uses insulation-piercing terminals for the contact members of the connector; these terminals cut through the insulation and establish an electrical connection to the conductor without preliminary stripping and without the conventional soldering step. These insulated-piercing terminals are usually of forked construction, with cutting edges that penetrate the wire insulation and that also serve as contact jaws that make the necessary electrical connection with the conductor. That is, a forked terminal element on the connector contact serves both as an insulation cutting device and as an electrical contact.

Contacts of miniature size may be constructed of sheet metal having a thickness in the order of 0.006 inches which is shaped to form elongated channels of about 0.200 inches long with a U-shaped cross section of about 0.050 wide by 0.060 inches deep. The resultant channels can be fragile and easily bent during electroplating operations and after processing prior to the mounting of the contact members in a dielectric contact mount. Under these circumstances, adequate support of the channel by its side and bottom walls is important.

According to the present invention there is provided an electrical contact member having a terminal element of sheet metal construction including at least one notch, the terminal element comprising an elongate channel of substantially U-shaped cross-section with opposite-facing sidewalls having opposite portions dimpled to protrude inwardly of the channel and thereby provide at least one pair of detents to define the at least one notch, each of the detents comprising two wall sections each being at a respective end thereof joined integrally to the sidewall in which the respective detent is formed, the other ends of the two wall sections joining together to define one side of the said notch and being such as to provide there an enlarged wiping surface, and the two wall sections providing at least one cutting edge at the entrance to the said notch, the cutting edge slanting down towards the bottom of the said channel.

A preferred embodiment of the invention includes an insulation-covered electrical connector having a terminal element of this sheet metal construction including at least one notch for cutting the insulation of an insulated conductor and electrically engaging its conductive core. The terminal element includes an elongated channel of U-shaped cross-sectional configuration with opposite facing sidewalls having opposite portions dimpled to protrude inwardly of the channel and to provide at least one pair of spaced apart detents. The notch is constituted by the space between the detents. The space between the detents is less than the distance between the sidewalls. Each detent includes a pair of wall sections. One end of

each wall section is integrally joined to the adjoining sidewall. The other ends of the sections are joined together in a curved portion at the notch to provide an enlarged wiping surface for the conductor. The curved portion has a free edge and a slit along the free edge. The slit includes at least one slanted cutting edge. The cutting edges of both wall sections are generally shaped to form a "V" shape with a longitudinal slope forming a medial portion at the junction with the wiping surface which acts to spread the insulation previously cut apart from a portion of the conductor.

The multi-walled construction of the detents provides enlarged wiping surfaces together with the desired degree of resiliency to yieldingly receive the metallic conductor. The contact also is of low cost and is easily manufactured.

FIGURE 1 is a side elevation view of an electrical connector provided with electrical contact members embodying the present invention.

FIGURE 2 is an enlarged sectional view of the connector along the line 2—2 of FIGURE 1, without the contact member normally in the left contact mounting passage.

FIGURE 3 is an enlarged perspective view partially in cross section of the rear portion of the connector in FIGURE 1 illustrating the construction of a sheet metal channel and inner detents.

FIGURE 4 is a similar view of the channel of FIGURE 3 with the separation between the detents being enlarged to show further details of the construction.

FIGURE 5 is a plan view of the channel of FIGURE 4.

FIGURE 6 is an end view of the channel and detents of FIGURE 5 with a conductor positioned in a lower portion of the notch.

FIGURE 7 is a partial plan view of a channel showing a second embodiment of the invention.

FIGURE 8 is a plan view of a third embodiment of the invention with a conductor (shown dotted) inserted between each of the two pairs of oppositely disposed inner detents.

FIGURE 9 is an end view taken approximately along line 9—9 of FIGURE 8.

FIGURE 10 is a perspective view of one of the detents in FIGURE 9.

FIGURES 1—2 illustrate the basic structure of an electrical connector unit having a plurality of electrical contact members constructed in accordance with one embodiment of the present invention. The electrical connector unit shown is a plug unit 10 adapted for conventional connection to a mating complimentary unit (not shown). Plug unit 10 comprises a contact mount 12 of molded dielectric material such as DAP (dyallyl phthalate), nylon, or polyester with a plurality of contact mounting passages 14 arranged parallel with one another in at least one row, two in the present example, transversely of the unit to receive a plurality of contact members 16. The passages 14 extend through a central base 18 which serves as a frame for mounting the unit 10 in a metallic shell (not shown) serving as an external support and are exposed on opposite sides of a front tongue-like portion 20 and a rear portion 22. The front portion 20 is enlarged with guides 21 for guiding and orienting unit 10 into the mating unit (not shown). Rear portion 22 is shaped to receive a plurality of insulation-covered conductors 24.

Each contact member 16 is a sheet metal construction which includes a contacting element 26 for engagement with a circuit element (not shown) frontwardly positioned in mount 12. The element 26 is a thin ribbon-like element 28 bent into a reentrant hook 30 captured in a small retaining slot 32 formed at the forward end 34 of the tongue portion 20. The ribbon-like element 28 also includes a smooth rounded convex bulge 31 to improve electrical engagement with mating circuit elements such as mating contact members. Contact member 16 further includes an integral terminal element 36 positioned in one of a respective channel portion 38 formed in the rear portion 22 and is adapted to interconnect the contact member 16 with a respective conductor 24. The terminal element 36 is shaped to include an open, elongated channel 40 of substantially U-shaped cross-sectional configuration 41 (FIGURE 3) which extends frontwardly (towards the right as viewed in Figure 3) into base 18 and includes one or more tabs 42 shaped for mounting the contact member in the mount 12.

As thus far described, the construction of connector unit 10 is essentially similar to the multiple contact electrical connector described and illustrated in Yopp's U.S. patent specification no. 3,002,176. The individual contact member 16 can be readily and rapidly mounted into corresponding individual passage 14 adjacent tongue 20 and moved rearwardly to the desired mounting position. Tab 42 on each member may then be bent laterally to lock the member in the mount.

FIGURE 3 represents an enlarged perspective view of one of the metallic channels 40 mounted in its respective channel portion 38 which communicates with a channel portion 39 serving in use as a strain relief for the respective conductor 24. As illustrated, barrier walls 44 separate adjacent channels portions 38—39 of the passages 14 and include tapered sidewalls 46 and 48 to guide the conductor (not shown) into an insulation-piercing portion 50 of metallic channel 40 and into the strain relief channel portion 39.

In accordance with the present invention and as illustrated in FIGURE 4, channel 40 is formed with sidewalls 52 and 53 and an

interconnecting bottom wall 54, serving to separate sidewalls 52 and 53 by a distance, to form an open three-sided channel. Opposite facing portions 55, 56, 57 and 58 of the sidewalls 52 and 53 are dimpled in to form detents 59, 60, 61 and 62 protruding inwardly of the channel and arranged in longitudinally displaced first and second detent pairs 64 and 66. The detents in each pair are separated by a distance less than the distance between the sidewalls and are oppositely positioned and form a conductor-receiving notch 68 with detent pair 64 and a conductor-receiving notch 70 with detent pair 66. As illustrated for detent 60, sidewall portion 56 is slit at the bottom 67 to permit the entire portion to be forced inwardly and form the detent.

Like the other detents, the detent 59 integrally joins the respective sidewall 52 at respective ends of two wall sections 72 and 74 which constitute the detent 59 and curve inwardly of the channel 40 to meet at their other ends at a distance from the sidewall 52. The detents are formed by the dimpling technique and are enlarged (by swaging) at the region where the respective wall sections of the detent meet each other. Thus in the detent 59, where the wall sections 72 and 74 join together they provide an enlarged, smooth curved surface 76 which constitutes one of a pair of such surfaces serving as wiping surfaces in the notch 68. The wall sections of each detent are furthermore cut at an angle to the bottom wall 54 of the channel 40 as can be seen in Fig. 6 to provide an entry at the respective notch for an insulation covered conductor and to expose cutting edges, for example the edges 78 and 80 indicated in Fig. 4, on the wall sections of the detents.

As illustrated in FIGURES 5—6, each notch is shaped by the defining detent pair to include a lower (as viewed) opening 82 sized slightly smaller than the conductor so that the wiping surfaces resiliently engage the conductor 24 and an upper (as shown) portion 84 with outwardly diverging boundaries 86 separated a maximum distance at least equal to the diameter 89 of the insulation 87 covering the conductor 24. The smooth, curved wiping surface of the section 76 protrudes from the sidewall 52 a distance equivalent to multiple thicknesses of the sheet metal and therefore resiliently yields when the conductor 24 is inserted rather than cutting or significantly deforming the conductor 24. The upper boundary 86 on each detent exposes the cutting edges 78 and 80 of the wall sections 72 and 74 so that the boundary is a symmetrical V-shaped outline, as indicated at 88 in FIGURE 4 or an asymmetrical V-shaped outline as indicated at 97 in FIGURE 10. As the wall sections 72 and 74 converge inwardly towards the notch 68, they also form a medial edge portion 90 as a transition zone for spreading the insulation 87 away from the conductor portion about to be inserted into the lower wiping section of the notch. The medial edge portion 90 is above the wiping surface 76 and between the cutting edges 72 and 74. In FIGURE 6, a conductor 24 is shown inserted into notch 68 and shows both detents 59—60 engaging the conductor.

In FIGURES 7—10, other embodiments of the detents are illustrated. FIGURE 7 illustrates the detents 92—93 swaged to further form a transition zone 94 where the insulation is spread apart from the conductor. In FIGURE 8 and 9, two detents 95—96 are illustrated with a V-shaped outline 97 which is not symmetrical, shown in FIGURE 10, to form essentially one curved insulation cutting and spreading edge 98. FIGURE 8 also includes inlet detents 99—100 in the form described and claimed in our Application No. 43122/73, Serial number 1,443,359.

The resultant construction as described above provides a terminal element particularly advantageous for miniature contacts in which the channels are formed from sheet metal stock such as cadmium copper plated with gold or other corrosion-resistant metal. The flanges are formed with detents integrally joined to the sidewalls of the channels and thereby aid in strengthening the channels so important for elongated narrow channels constructed of thin sheet metal.

WHAT WE CLAIM IS:—

1. An electrical contact member having a terminal element of sheet metal construction including at least one notch, the terminal element comprising an elongate channel of substantially U-shaped cross-section with opposite-facing sidewalls having opposite portions dimpled to protrude inwardly of the channel and thereby provide at least one pair of detents to define the at least one notch, each of the detents comprising two wall sections each being at a respective end thereof joined integrally to the sidewall in which the respective detent is formed, the other ends of the two wall sections joining together to define one side of the said notch and being such as to provide there an enlarged wiping surface, and the two wall sections providing at least one cutting edge at the entrance to the said notch, the cutting edge slanting down towards the bottom of the said channel.

2. An electrical contact member according to claim 1, wherein the upper boundary at each detent as seen in side view, relative to the channel, defines an outline which is substantially V-shaped.

3. An electrical contact member according to claim 2, wherein the said substantially V-shaped outline is symmetrical relative to a line perpendicular to the bottom of the channel.

4. An electrical contact member according to claim 2, wherein the said substantially V-shaped outline is not symmetrical relative to

a line perpendicular to the bottom of the channel.

5. An electrical contact member according to claim 1 or 2 or 3, wherein the upper boundary at each detent includes a medical portion shaped to spread insulation away from an insulation covered conductor inserted in use into the channel.

6. An electrical connector including a contact mount formed of molded dielectric material and having a plurality of contact-mounting passages, and a pluarlity of contact members according to any preceding claim, each one of the said contact members being mounted on a respective one of the said contact-mounting passages.

7. An electrical contact member substantially as described hereinbefore with reference to and as shown in Figs. 4, 5 and 6, or with reference to and as shown in Fig. 7, or with reference to and as shown in Figs. 8, 9 and 10 of the accompanying drawings.

8. An electrical connector according to claim 6 and substantially as described hereinbefore with reference to and as shown in Figs. 1 to 6 of the accompanying drawings.

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1451357 COMPLETE SPECIFICATION
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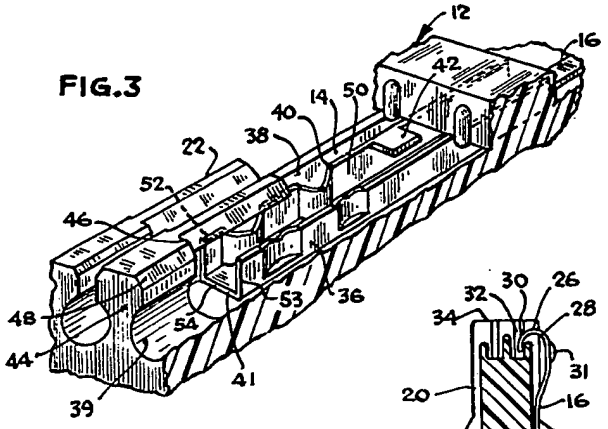
Sheet 1

FIG.3



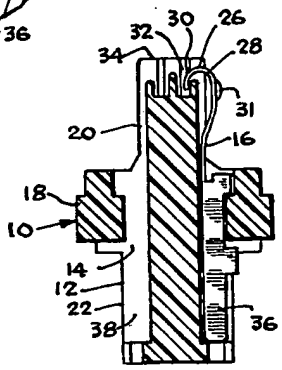
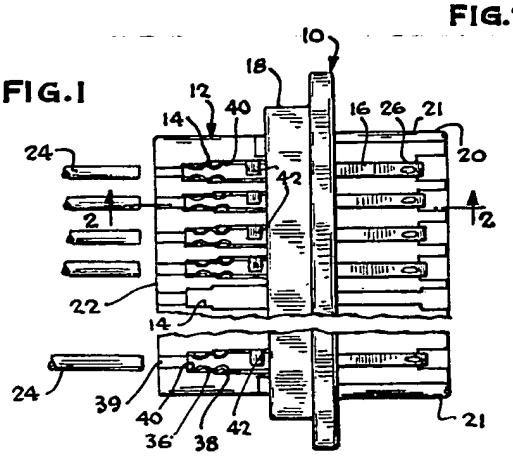


FIG.2

FIG.1



1451357 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

FIG.4

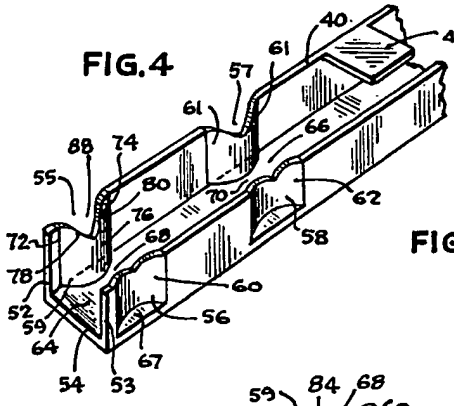


FIG.5

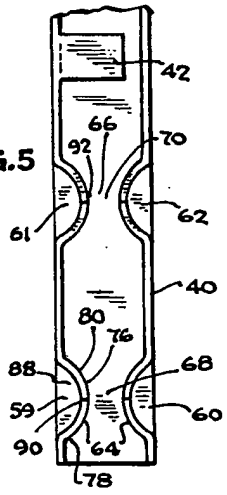


FIG.6

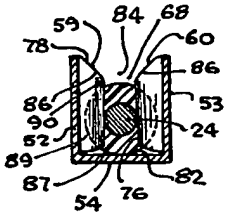


FIG.7

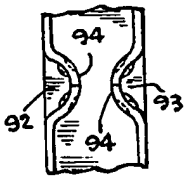


FIG.8

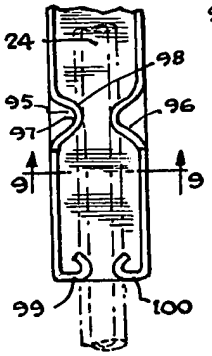


FIG.9

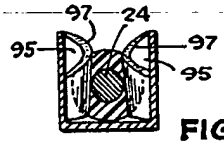


FIG.10